Remarks

The following remarks are responsive to the Office Action, dated November 1, 2005, in the above referenced pending application. Applicant respectfully requests reconsideration in view of the remarks presented below and withdrawal of the rejections.

Amendments to the Specification

The specification is being amended to correct a systematic typographical error in equations 1, 2 and 5. In addition, the expression for the total phase change, ϕ, of the radiation reflected by an ideal reflector at λ, has been amended by adding elements per standard wave equations. Applicant respectfully requests that these amendments be entered. Support therefor is discussed in detail below.

Status of the Claims

Claims 1, 3, 5, 6, 9-13 and 19 are pending.

Claims 3 and 9 stand rejected under 35 U.S.C. §112.

Claims 1, 5, 6, 10 and 19 stand rejected under 35 U.S.C. §102.

Claims 11-13 stand rejected under 35 U.S.C. §103.

Claims 3, 9, 10-13, and 19 are objected to in that each depends from a canceled claim. Claims 3, 9-11 and 19 have been amended to provide proper dependency to the elected claims. The amendment to Claim 11 corrects the dependencies for Claims 12 and 13, which have not been amended. Accordingly, the informalities cited by the Examiner have been appropriately corrected. Applicant wishes to thank the Examiner for pointing out these informalities.

Claims 3 and 9 have been further amended to correct a typographical error in Equations 1 and 2 and to clarify the wavelength dependency of the total phase change, ϕ. No new matter is introduced.

Applicant respectfully requests that the claim amendments be entered.

Rejections under 35 U.S.C. § 112, second paragraph: Claims 3 and 9

Claims 3 and 9 were rejected under 35 U.S.C. § 112, second paragraph, as being indefinite. A typographical error in Equations 1, 2 and 5 has been corrected in Claims 3 and 9 and in the Specification where cited above, bringing the units of length on both sides of the equation into agreement. Equations 1, 2 and 5 are based on standard wave equations for constructive and destructive interference, which can be found in most basic optics textbooks. For example, see the *Handbook of Optics, Volume I: Fundamentals, Techniques, and Design, Second Edition*, 1995, published by McGraw Hill, Inc., on page 2.7 at Table 1 and its description of constructive and destructive interference; on page 2.21 at equation (49) and its description of the angular dependence of wave interference; and on page 2.24 at equations

(51) and (52) and their description of constructive and destructive interference. Copies of these pages are attached for the Examiner's convenience.

In addition, the description of the total phase change, ϕ, has been amended in the Specification at the places indicated above as well as Claims 3 and 9 to clarify the description of the relationship between the optical path difference and the specific wavelength, λ, at which it is observed. This relationship is based on standard wave equations and can be found, for example, in the above cited reference on page 2.7 at equation (17) and its description (see attached).

Applicants respectfully request that the Examiner withdraw the above referenced rejection based upon the foregoing clarifying amendments and the explanation therefor presented above.

Rejections under 35 U.S.C. § 102(b): Claims 1, 5, 6, 10 and 19

Claims 1, 5, 6, 10 and 19 are rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,232,714 ("*Shen*"). Applicant respectfully traverses this rejection. Regarding independent Claims 1 and 5, the *Shen* disclosure addresses optical cavities in a stacked organic light emitting device (SOLED), where the optical cavities can shift, or attenuate, the wavelength of the emitted light to modify, or filter, the color of emitted light, and to improve the external quantum efficiency of the SOLED. Table 1 of *Shen* describes the materials, thicknesses and optical parameters (index of refraction and path length) used to model the filtering effects of a SOLED. There is no information in Table 1 of *Shen*, or the accompanying description of Table 1, that describes $L_{background}$, the reflected ambient light from the device (*see* the pending application at page 8, lines 29-30), or how to achieve low $L_{background}$. The change in color saturation and external quantum efficiency taught by *Shen* are separate optical phenomenon from the ambient contrast ratio improvement of pending independent Claims 1 and 5.

Claim 1 recites as a limitation an organic active layer configured to achieve low $L_{background}$. Claim 5 recites that the first electrode layer is configured to achieve low $L_{background}$. Claim 6 requires the second electrode to be configured to achieve low $L_{background}$. Claim 10 calls for an interfacial reflectivity no greater than about 30%. Low $L_{background}$ is defined in the specification on page 6, line 37 to page 7, line 2, and interfacial reflectivity is defined on page 6, lines 32-36. Equations 1, 2 and 5 relate to configuration to achieve low $L_{background}$ while Equation 3 relates to interfacial reflectivity. Claims 6 and 10 depend from Claim 5 and therefore include the elements of that independent claim; Claim 19 depends from Claim 1 or Claim 5. None of these claim elements are disclosed or suggested by *Shen*.

Since *Shen* fails to teach or suggest all of the elements of independent Claims 1 and 5, *Shen* does not teach or suggest every element of dependent Claims 6, 10 and 19. Applicants earnestly request that the above referenced rejection be withdrawn.

Rejections under 35 U.S.C. § 103(a): Claims 11-13

Claims 11-13 are rejected under 35 U.S.C. § 103(a) as being unpatentable over *Shen* in view of U.S. Patent No. 6,307,528 (*"Yap"*). For the reasons stated above, Applicant respectfully asserts that *Shen* does not teach the organic electronic device as claimed in pending Claims 11-13. In particular, Claims 11-13 ultimately depend from independent Claim 5, which recites an organic electronic device comprising an organic active layer and a first electrode having a side opposite the organic active layer, wherein the first electrode comprises a first electrode layer laying at the side opposite the organic active layer and the first electrode is configured to achieve low $L_{background}$. *Yap* does not make up the deficiencies of *Shen* in that it does not teach or suggest the elements missing from *Shen* and does not teach or suggest an organic electronic device comprising an organic active layer and a first electrode having a side opposite the organic active layer, wherein the first electrode comprises a first electrode layer laying at the side opposite the organic active layer and the first electrode is configured to achieve low $L_{background}$.

Applicant respectfully traverses the Examiner's assertion that *Yap* discloses an electrode layer comprising a metal selected from a transition metal and an elemental metal or an oxide of said metal in order to lower reflectance. *Yap* discloses an electrode layer (an anode and a cathode)(Col. 2, lines 23-24). Suitable cathode compositions include a thin layer of Mg/Ag with a thicker layer of ITO atop that. ITO is a suitable anode composition. *Yap* applies a low-reflectance material comprising a film to the substrate (the substrate may be transparent, non-transparent or even reflective). The electrodes (anode and cathode) are preferably transparent. Please see *Yap* at Col. 4, lines 23-34; Col. 4, lines 48-57; and Col. 4, lines 47-48. The low-reflectance coating may be made from alternating layers of chrome and chrome oxide or silicon and silicon oxide (Col. 4, lines 26-28). *Yap* accordingly teaches away from present Claims 11-13 in teaching that the electrodes are made from materials other than a transition metal or an elemental metal or an oxide thereof. Contrary to the Examiner's assertion, *Yap* teaches that the electrodes are preferably transparent. (Col. 4, lines 47-49). *Shen* teaches a thick, high work function metal layer 17" (*sic.*) such as Au or Ag on the Mg/Ag layer and that the thick metal is opaque. (Col. 1, lines 47-51). The Mg/Ag and Au or Ag layers in *Shen* comprise electrode 17. Since *Shen* uses a thick metal layer of high work function as a component of an electrode, there would be no motivation to combine *Shen* with *Yap* (low-reflectance film coating).

Consequently, neither *Shen* or *Yap*, when read alone or together, teach or suggest the subject matter of pending Claims 11-13. Thus, the above referenced rejection should be withdrawn.

Conclusion

In view of the above amendments and remarks, Applicants submit that the case is in condition for allowance. A Notice of Allowance is respectfully solicited.

Applicant believes that the fee for a two-month extension of time pursuant to 37 C.F.R. §1.136(a) as set forth in 37 C.F.R. §1.17(a)(2) ($450.00) is required with the submission of this paper. The due date for response fell on Saturday April 1, 2006, so that by virtue of 37 C.F.R. §1.7(a), the paper is deemed to be timely filed within the second month's extension if filed on Monday April 3, 2006. Please charge said fee to Deposit Account No. 04-1928 (E.I. du Pont de Nemours and Company). Should a fee not accounted for herein also be due, please charge said fee to the same deposit account.

Should the Examiner have questions about the contents of this paper or the status of the application, the Examiner is invited to call the undersigned at the telephone number listed below.

Respectfully submitted,

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Dated: April 3, 2006

HANDBOOK OF OPTICS

Volume I
Fundamentals, Techniques, and Design

Second Edition

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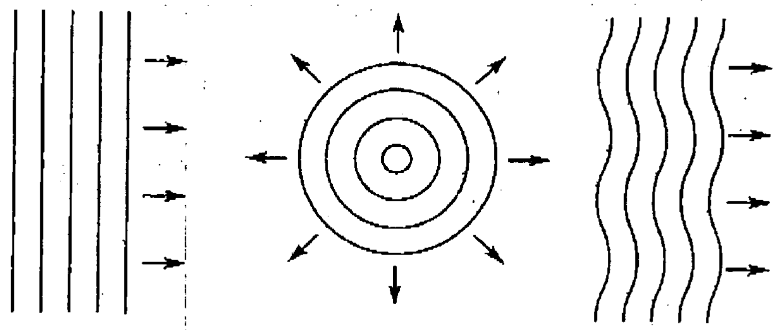

(a) (b) (c)

FIGURE 1 Examples of wavefronts: (*a*) plane wave; (*b*) spherical wave; and (*c*) aberrated plane wave.

entire surface of a sphere. In practice, we only need to consider an angular segment of a spherical wave, in which case this polarization concern disappears.

Wavefronts

Wavefronts represent surfaces of constant phase for the electromagnetic field. Since they are normally used to show the spatial variations of the field, they are drawn or computed at a fixed time. Wavefronts for plane and spherical waves are shown in Fig. 1*a* and *b*. The field is periodic, and a given value of phase will result in multiple surfaces. These surfaces are separated by the wavelength. A given wavefront also represents a surface of constant optical path length (OPL) from the source. The OPL is defined by the following path integral:

$$\mathrm{OPL} = \int_S^P n(s)\, ds \tag{9}$$

where the integral goes from the source S to the observation point P, and $n(s)$ is the index of refraction along the path. Variations in the index or path can result in irregularities or aberrations in the wavefront. An aberrated plane wavefront is shown in Fig. 1c. Note that the wavefronts are still separated by the wavelength.

The local normal to the wavefront defines the propagation direction of the field. This fact provides the connection between wave optics and ray or geometrical optics. For a given wavefront, a set of rays can be defined using the local surface normals. In a similar manner, a set of rays can be used to construct the equivalent wavefront.

2.4 INTERFERENCE

The net complex amplitude is the sum of all of the component fields,

$$\mathbf{E}(x, y, z, t) = \sum_i \mathbf{E}_i(x, y, z, t) \tag{10}$$

and the resulting field intensity is the time average of the modulus squared of the total complex amplitude

$$I(x, y, z, t) = \langle |\mathbf{E}(x, y, z, t)|^2 \rangle \tag{11}$$

where $\langle\ \rangle$ indicates a time average over a period much longer than $1/\nu$. If we restrict ourselves to two interfering waves $\mathbf{E}_1$ and $\mathbf{E}_2$, this result simplifies to

$$I(x, y, z, t) = \langle|\mathbf{E}_1|^2\rangle + \langle|\mathbf{E}_2|^2\rangle + \langle\mathbf{E}_1 \cdot \mathbf{E}_2^*\rangle + \langle\mathbf{E}_1^* \cdot \mathbf{E}_2\rangle \tag{12}$$

or

$$I(x, y, z, t) = I_1 + I_2 + \langle\mathbf{E}_1 \cdot \mathbf{E}_2^*\rangle + \langle\mathbf{E}_1^* \cdot \mathbf{E}_2\rangle \tag{13}$$

where I_1 and I_2 are the intensities due to the two beams individually, and the (x, y, z, t) dependence is now implied for the various terms.

This general result can be greatly simplified if we assume linearly polarized monochromatic waves of the form in Eq. (3):

$$\mathbf{E}_i(x, y, z, t) = \mathbf{A}_i(x, y, z)e^{i(\omega_i t - \phi_i(x, y, z))} \tag{14}$$

The resulting field intensity is

$$I(x, y, z, t) = I_1 + I_2 + 2(\mathbf{A}_1 \cdot \mathbf{A}_2)\cos[(\omega_1 - \omega_2)t - (\phi_1(x, y, z) - \phi_2(x, y, z))] \tag{15}$$

The interference effects are contained in the third term, and we can draw two important conclusions from this result. First, if the two interfering waves are orthogonally polarized, there will be no visible interference effects, as the dot product will produce a zero coefficient. Second, if the frequencies of the two waves are different, the interference effects will be modulated at a temporal beat frequency equal to the difference frequency.

Interference Fringes

We will now add the additional restrictions that the two linear polarizations are parallel and that the two waves are at the same optical frequency. The expression for the intensity pattern now becomes

$$I(x, y, z) = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos[\Delta\phi(x, y, z)] \tag{16}$$

where $\Delta\phi = \phi_1 - \phi_2$ is the phase difference. This is the basic equation describing interference. The detected intensity varies cosinusoidally with the phase difference between the two waves as shown in Fig. 2. These alternating bright and dark bands in the

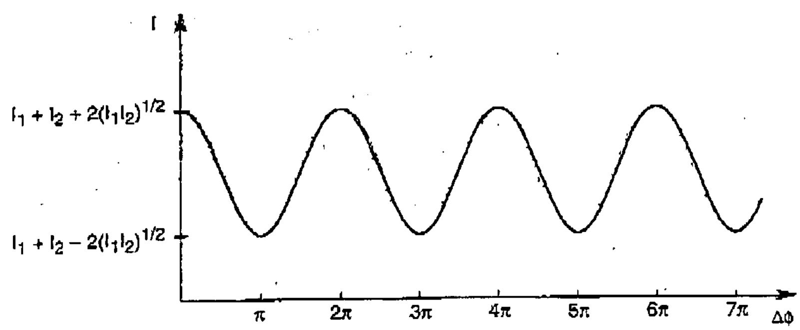

FIGURE 2 The variation in intensity as a function of the phase difference between two interfering waves.

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TABLE 1 The Phase Difference and OPD for Bright and Dark Fringes (m an Integer)

	$\Delta\phi$	OPD
Bright fringe	$2m\pi$	$m\lambda$
Dark fringe	$2(m+1)\pi$	$(m+1/2)\lambda$

intensity pattern are referred to as *interference fringes*, and along a particular fringe, the phase difference is constant.

The phase difference is related to the difference in the optical path lengths between the source and the observation point for the two waves. This is the *optical path difference* (OPD):

$$\mathrm{OPD} = \mathrm{OPL}_1 - \mathrm{OPL}_2 = \left(\frac{\lambda}{2\pi}\right)\Delta\phi \tag{17}$$

or

$$\Delta\phi = \left(\frac{2\pi}{\lambda}\right)\mathrm{OPD} \tag{18}$$

The phase difference changes by 2π every time the OPD increases by a wavelength. The OPD is therefore constant along a fringe.

Constructive interference occurs when the two waves are in phase, and a bright fringe or maximum in the intensity pattern results. This corresponds to a phase difference of an integral number of 2π's or an OPD that is a multiple of the wavelength. A dark fringe or minimum in the intensity pattern results from *destructive interference* when the two waves are out of phase by π or the OPD is an odd number of half wavelengths. These results are summarized in Table 1. For conditions between these values, an intermediate value of the intensity results. Since both the OPD and the phase difference increase with the integer m, the absolute value of m is called the *order of interference*.

As we move from one bright fringe to an adjacent bright fringe, the phase difference changes by 2π. Each fringe period corresponds to a change in the OPD of a single wavelength. It is this inherent precision that makes interferometry such a valuable metrology tool. The wavelength of light is used as the unit of measurement. Interferometers can be configured to measure small variations in distance, index, or wavelength.

When two monochromatic waves are interfered, the interference fringes exist not only in the plane of observation, but throughout all space. This can easily be seen from Eq. (16) where the phase difference can be evaluated at any z position. In many cases, the observation of interference is confined to a plane, and this plane is usually assumed to be perpendicular to the z axis. The z dependence in Eq. (16) is therefore often not stated explicitly, but it is important to remember that interference effects will exist in other planes.

Fringe Visibility

It is often more convenient to rewrite Eq. (16) as

$$I(x, y) = I_0(x, y)\{1 + \gamma(x, y)\cos[\Delta\phi(x, y, z)]\} \tag{19}$$

or

$$I(x, y) = I_0(x, y)\{1 + \gamma(x, y)\cos[2\pi\mathrm{OPD}(x, y)/\lambda]\} \tag{20}$$

With an extended source, the fringes will be localized where the individual fringe position or spacing is not affected by the location of the point sources that comprise the extended source. We know from our previous examples that a bright fringe (or a dark fringe, depending on phase shifts) will occur when the OPD is zero. If there is a location where the OPD is zero independent of source location, all of the individual interference patterns will be in phase, and the net pattern will show good visibility. In fact, the three-dimensional fringe pattern due to a point source will tend to shift or pivot around this zero-OPD location as the point source location is changed. The individual patterns will therefore be out of phase in areas where the OPD is large, and the average intensity pattern will tend to wash out in these regions as the source size increases.

The general rule for fringe visibility with an extended quasi-monochromatic source is that the fringes will be localized in the region where the OPD between the two interfering wavefronts is small. For a wedged glass plate, the fringes are localized in or near the wedge, and the best visibility occurs as the wedge thickness approaches zero and is perhaps just a few wavelengths. The allowable OPD will depend on the source size and the method of viewing the fringes. This result explains why, under natural light, interference effects are seen in thin soap bubbles but not with other thicker glass objects. An important exception to this rule is the plane-parallel plate where the fringes are localized at infinity.

Fringes of Equal Inclination

There is no section of a plane-parallel plate that produces two reflected wavefronts with zero OPD. The OPD is constant, and we would expect, based on the previous section, that no high-visibility fringes would result with an extended source. If, however, a lens is used to collect the light reflected from the plate, fringes are formed in the back focal plane of the lens. This situation is shown in Fig. 12, and any ray leaving the surface at a particular angle θ is focused to the same point P. For each incident ray at this angle, there are two parallel reflected rays: one from the front surface and one from the back surface. The reflections from different locations on the plate at this angle are due to light from different points in the extended source. The OPD for any pair of these reflected rays is the same regardless of the source location. These rays will interfere at P and will all have the same phase difference. High-visibility fringes result. Different points in the image plane correspond to different angles. The formation of these fringes localized at infinity depends on the two surfaces of the plate being parallel.

The OPD between the reflected rays is a function of the angle of incidence θ, the plate index n, and thickness t:

$$\text{OPD} = 2nt\cos\theta' \tag{48}$$

where θ' is the internal angle. Taking into account the half-wave shift due to the phase change difference of π between an internal and an external reflection, a dark fringe will result for angles satisfying

$$2nt\cos\theta' = m\lambda \qquad \text{or} \qquad \cos\theta' = \frac{m\lambda}{2nt} \tag{49}$$

where m is an integer. Since only the angle of incidence determines the properties of the interference (everything else is constant), these fringes are called *fringes of equal inclination*. They appear in the back focal plane of the lens and are therefore localized at infinity since infinity is conjugate to the focal plane. As the observation plane is moved away from the focal plane, the visibility of the fringes will quickly decrease.

When the axis of the lens is normal to the surfaces of the plate, a beamsplitter arrangement is required to allow light from the extended source to be reflected into the lens as shown in Fig. 13. Along the axis, $\theta = \theta' = 90°$, and symmetry requires that the

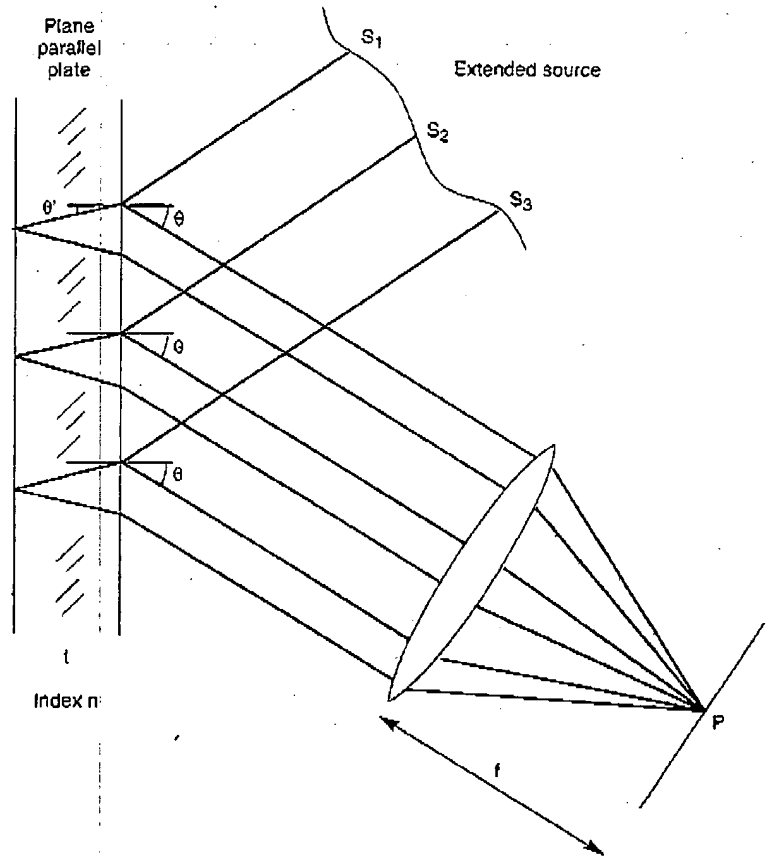

FIGURE 12 The formation of fringes of equal inclination.

fringes are concentric about the axis. In this special case, these fringes are called *Haidinger fringes*, and they are identical in appearance to Newton's rings [Eq. (30)]. If there is an intensity maximum at the center, the radii of the other bright fringes are proportional to the square roots of integers. As with other fringes formed by a plane-parallel plate (discussed earlier), the order of interference decreases with the observation radius on the screen. As θ' increases, the value of m decreases.

Fringes of Equal Thickness

The existence of fringes of equal inclination depends on the incident light being reflected by two parallel surfaces, and the angle of incidence is the mechanism which generates changes in the OPD. There are many arrangements with an extended source where the reflections are not parallel, and the resulting changes in OPD dominate the angle-of-incidence considerations. The fringes produced in this situation are called *fringes of equal*

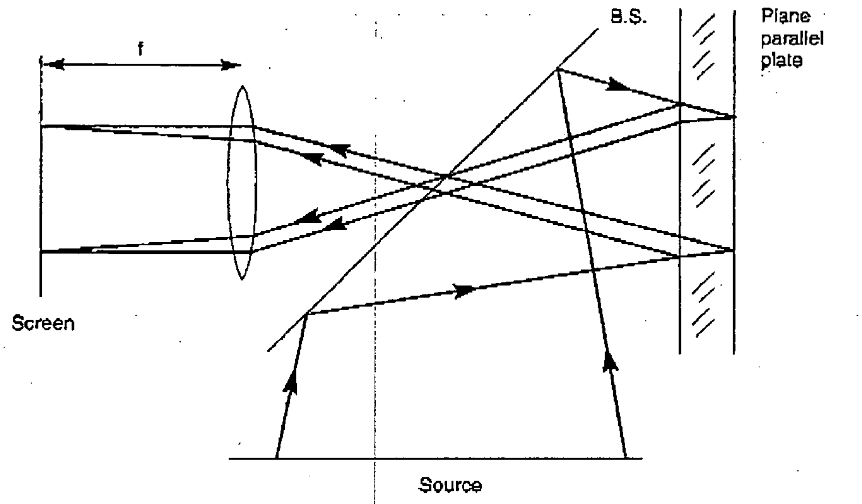

FIGURE 13 The formation of Haidinger fringes.

thickness, and we have stated earlier that they will be localized in regions where the OPD between the two reflections is small.

An example of fringes of equal thickness occurs with a wedged glass plate illuminated by a quasi-monochromatic extended source. We know that for each point in the source, a pattern comprised of equispaced parallel fringes results, and the net pattern is the sum of all of these individual patterns. However, it is easier to examine this summation by looking at the OPD between the two reflected rays reaching an observation point P from a source point S. This is shown in Fig. 14. The wedge angle is α, the thickness of the plate at this

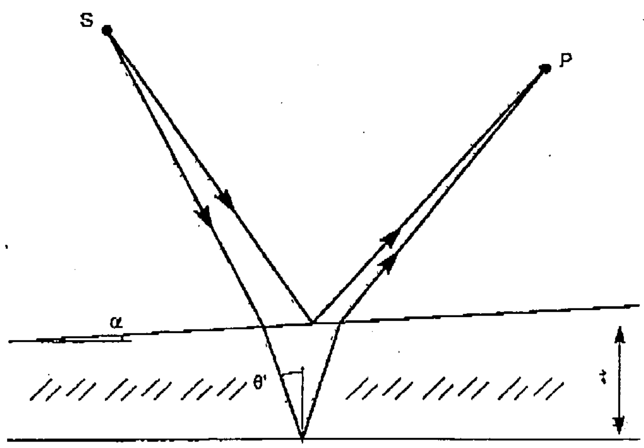

FIGURE 14 The ray path between a point source and an observation point for a wedged plate.

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location is t, its index is n, and the internal ray angle is θ'. The exact OPD is difficult to calculate, but under the assumption that α is small and the wedge is sufficiently thin, the following result for the OPD is obtained:

$$\text{OPD} \approx 2nt \cos \theta' \tag{50}$$

As other points on the source are examined, the reflection needed to get light to the observation point will move to a different location on the plate, and different values of both t and θ' will result. Different source points may have greatly different OPDs, and in general the fringe pattern will wash out in the vicinity of P.

This reduction in visibility can be avoided if the observation point is placed in or near the wedge. In this case, all of the paths between S and P must reflect from approximately the same location on the wedge, and the variations in the thickness t are essentially eliminated. The point P where the two reflected rays cross may be virtual. The remaining variations in the OPD are from the different θ''s associated with different source points. This variation may be limited by observing the fringe pattern with an optical system having a small entrance pupil. This essentially limits the amount of the source that is used to examine any area on the surface. A microscope or the eye focused on the wedge can be used to limit the angles. If the range of values of θ' is small, high-visibility fringes will appear to be localized at the wedge. The visibility of the fringes will decrease as the wedge thickness increases.

It is common to arrange the system so that the fringes are observed in a direction approximately normal to the surface. Taking into account the additional phase shift introduced at the reflection from one of the surfaces, the conditions for bright and dark fringes are then

$$\text{Bright:} \quad 2nt - \frac{\lambda}{2} = m\lambda \tag{51}$$

and

$$\text{Dark:} \quad 2nt = m\lambda \tag{52}$$

where m is an integer greater than or equal to zero. Since t increases linearly across the wedge, the observed pattern will be straight equispaced fringes.

These same conditions hold for any plate where the two surfaces are not parallel. The surfaces may have any shape, and as long as the surface angles are small and the plate is relatively thin, high-visibility fringes localized in the plate are observed. Along a given fringe the value of m is constant, so that a fringe represents a contour of constant optical path length nt. If the index is constant, we have fringes of equal thickness. The fringes provide a contour map of the plate thickness, and adjacent fringes correspond to a change of thickness of $\lambda/2n$. An irregularly shaped pattern will result from the examination of a plate of irregular thickness.

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Thin Films

With the preceding background, we can easily explain the interference characteristics of *thin films*. There are two distinct types of films to consider. The first is a thin film of nonuniform thickness, and examples are soap bubbles and oil films on water. The second type is a uniform film, such as would be obtained by vacuum deposition and perhaps used as an antireflection coating. Both of these films share the characteristic of being extremely thin—usually not more than a few wavelengths thick and often just a fraction of a wavelength thick.

With a nonuniform film, fringes of equal thickness localized in the film are produced.

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There will be a dark fringe in regions of the film where it is substantially thinner than a half wave. We are assuming that the film is surrounded by a lower-index medium such as air so that there is an extra π phase shift. If white light is used for illumination, colored bands will be produced similar to those diagramed in Fig. 10*b* (the curves would need to be modified to rescale the x axis to OPD or film thickness). Each color will produce its first maximum in intensity when the optical thickness of the film is a quarter of that wavelength. As the film thickness increases, the apparent fringe color will first be blue, then green, and finally red. These colored fringes are possible because the film is very thin, and the order of interference m is often zero or one [Eqs. (51) and (52)]. The interference patterns in the various colors are just starting to get out of phase, and interference colors are visible. As the film thickness increases, the various wavelength fringes become jumbled, and distinct fringe patterns are no longer visible.

When a uniform thin film is examined with an extended source, fringes of equal inclination localized at infinity are produced. These fringes will be very broad since the thickness of the film is very small, and large angles will be required to obtain the necessary OPD for a fringe [Eq. (49)]. A common use of this type of film is as an antireflection coating. In this application, a uniform coating that has an optical thickness of a quarter wavelength is applied to a substrate. The coating index is lower than the substrate index, so an extra phase shift is not introduced. A wave at normal incidence is reflected by both surfaces of the coating, and these reflected waves are interfered. If the incident wavelength matches the design of the film, the two reflected waves are out of phase and interfere destructively. The reflected intensity will depend on the Fresnel reflection coefficients at the two surfaces, but will be less than that of the uncoated surface. When a different wavelength is used or the angle of incidence is changed, the effectiveness of the antireflection coating is reduced. More complicated film structures comprised of many layers can be produced to modify the reflection or transmission characteristics of the film.

Fizeau Interferometer

The *Fizeau interferometer* compares one optical surface to another by placing them in close proximity. A typical arrangement is shown in Fig. 15, where the extended source is filtered to be quasi-monochromatic. A small air gap is formed between the two optical surfaces, and fringes of equal thickness are observed between the two surfaces. Equations (51) and (52) describe the location of the fringes, and the index of the thin wedge is now that of air. Along a fringe, the gap is of constant thickness, and adjacent fringes correspond to a change of thickness of a half wavelength. This interferometer is sometimes referred to as a *Newton interferometer.*

This type of interferometer is the standard test instrument in an optical fabrication shop. One of the two surfaces is a reference or known surface, and the interferometric comparison of this reference surface and the test surface shows imperfections in the test part. Differences in radii of the two surfaces are also apparent. The fringes are easy to interpret, and differences of as little as a twentieth of a wavelength can be visually measured. These patterns and this interferometer are further discussed in Chap. 30, Vol. 2, "Optical Testing." The interferometer is often used without the beamsplitter, and the fringes are observed in the direct reflection of the source from the parts.

The classic fringe pattern produced by a Fizeau interferometer is *Newton's rings.* These are obtained by comparing a convex sphere to a flat surface. The parabolic approximation for the sag of a sphere of radius R is

$$\mathrm{sag}(\rho) = \frac{\rho^2}{2R} \tag{53}$$

and ρ is the radial distance from the vertex of the sphere. If we assume the two surfaces